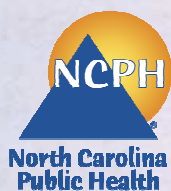
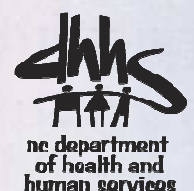


THE BURDEN OF Traumatic Brain Injury (TBI) in North Carolina



North Carolina
Injury & Violence
PREVENTION Branch



THE BURDEN OF Traumatic Brain Injury in North Carolina May 2010

Katherine J. Harmon, MPH



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Acknowledgements:

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Highlights:

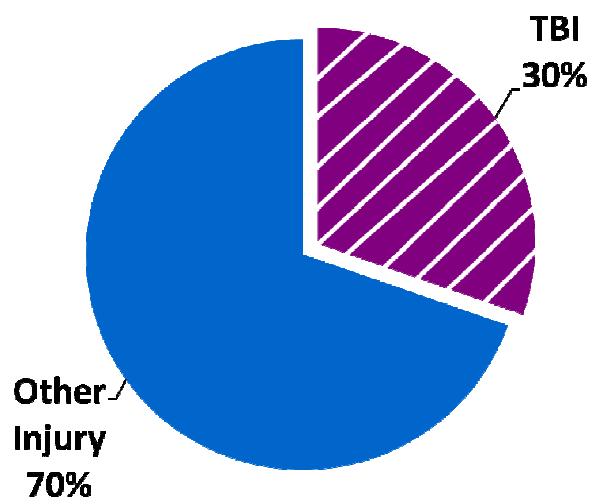
- In 2008, 1,903 North Carolina residents died after sustaining a traumatic brain injury (TBI).
- TBIs accounted for 30 percent of all injury deaths in 2008.
- The rate of TBI deaths is 20.6 per 100,000 North Carolina residents.
- Males are nearly three times as likely to die from TBIs as females.
- American Indians have the highest rate of death due to TBIs in North Carolina.
- In 2008, the rate of death due to TBIs increased with increasing age. Individuals over the age of 84 have the highest mortality rates for all age groups.
- The three most common causes of TBI deaths were firearms, motor vehicle-traffic (MVT) crashes, and falls.

Overview and Trends of Traumatic Brain Injuries (TBI) in North Carolina:

Injury is the third-leading cause of death in North Carolina; only heart disease and cancer cause more deaths in the state¹. Injury is the leading cause of death in individuals between the ages of one and 44². In 2008 alone, injury was cited as the primary cause of death in 6,275 deaths.

One of the more common forms of injury in North Carolina is traumatic brain injury (TBI). Although TBI is not a manner or specific cause of injury, its frequency and potential for both disability and death warrant attention. In 2008, 1,903 deaths were due to TBI. TBIs accounted for about 30 percent of all injury deaths (Figure 1).

Figure 1: Percent of Injury Deaths due to Traumatic Brain Injuries (TBI): North Carolina Residents, 2008



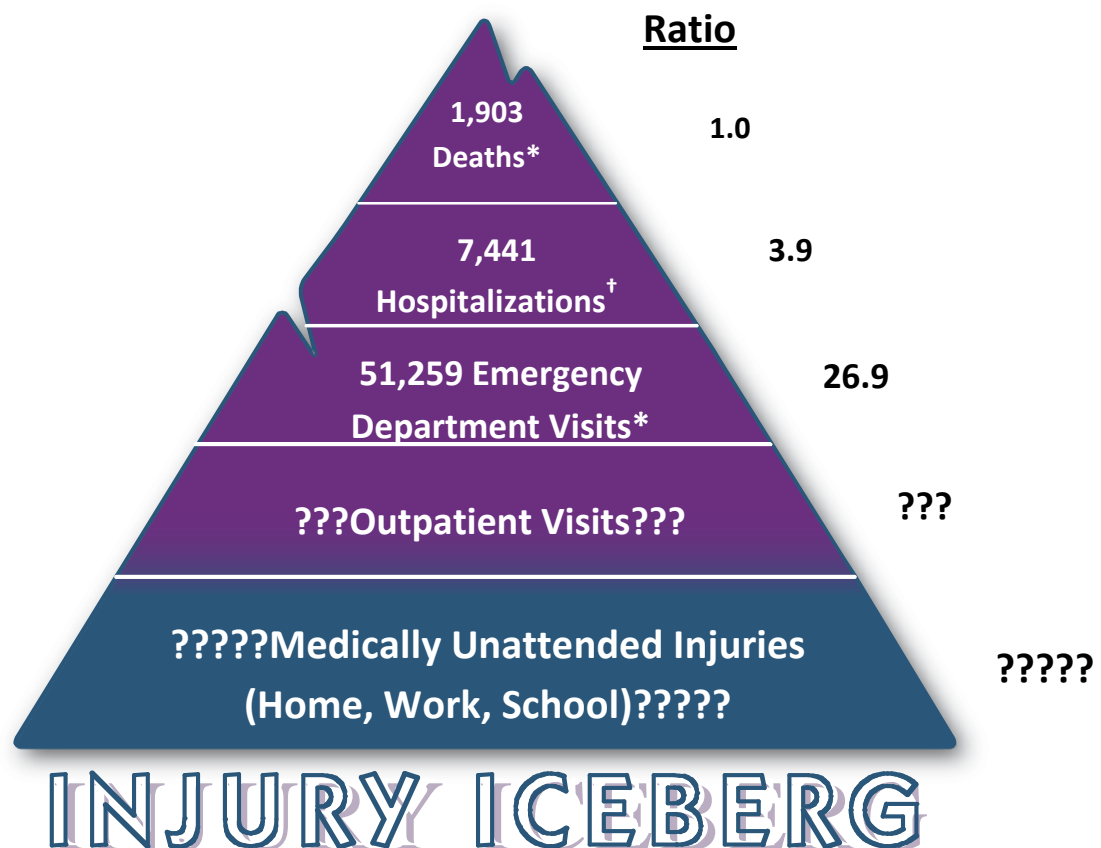
Data: NC Center for Health Statistics, 2008
Analysis: Injury Epidemiology and Surveillance Unit

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TBIs occur when acute trauma damages the brain and may lead to a closed or penetrating head injury³. The Centers for Disease Control and Prevention refer to TBI as the “silent epidemic”, because many of the signs, symptoms, and sequelae of TBI, such as memory loss, are not readily recognized by the public. TBIs vary in severity from mild injuries that require minimal medical attention to severe injuries that may cause death or life-long disability. In the United States, approximately 50,000 people die, 235,000 people are hospitalized, and 1.1 million people visit an emergency department (ED) due to a TBI each year⁴. These numbers do not reflect the untold thousands who visit a primary care physician or seek no medical attention. Of the many who survive their injuries, about 80,000 will suffer some form of disability³.

The Injury Iceberg illustrates the overall burden that TBI has on the population of North Carolina. Deaths account for only the “tip” of the iceberg in regards to TBI injuries. For each death, there are 3.9 hospitalizations and 26.9 ED visits^{5, 6, 7}. Surveillance data are not available for outpatient clinics or for TBIs that are not medically attended; however, these numbers are likely to be far higher than the number of ED visits (Figure 2).

Figure 2: The Injury Iceberg—TBI Injuries: North Carolina Residents, 2007 and 2008



*Data is from 2008.

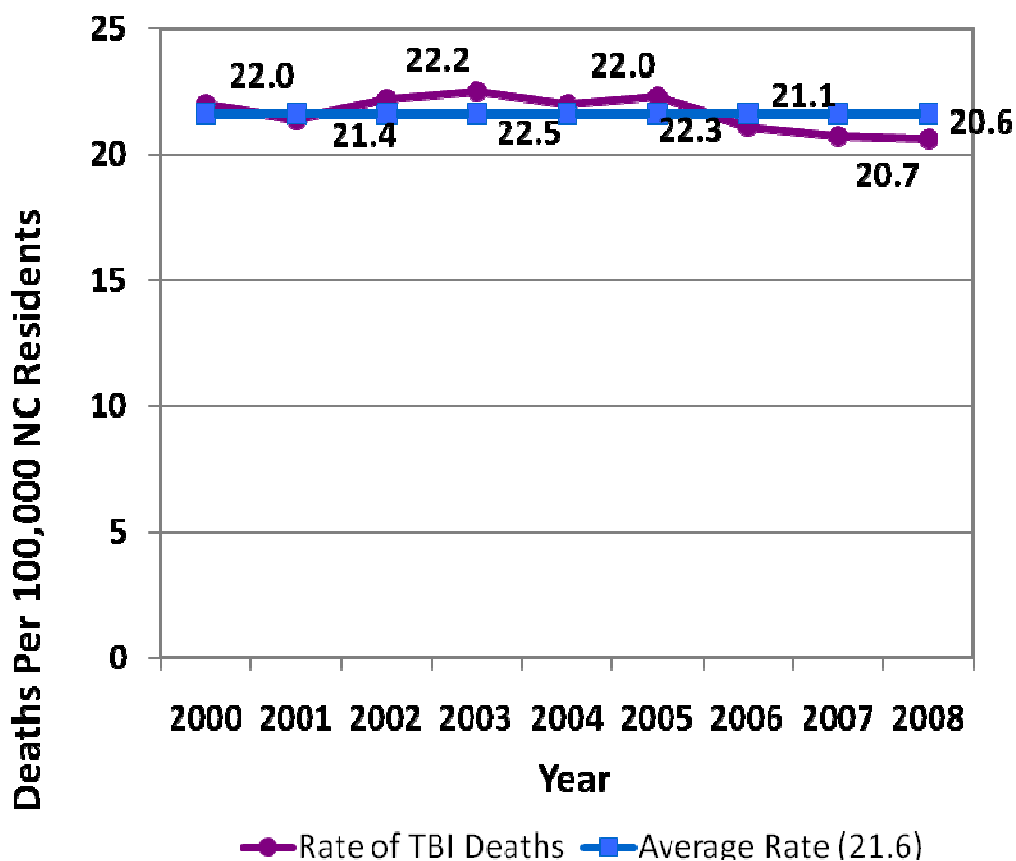
[†]Data is from 2007.

Data: NC Center for Health Statistics, 2007, 2008; NC DETECT, 2008
Analysis: Injury Epidemiology and Surveillance Unit

Deaths from TBIs have remained relatively stable over the last decade. The average rate of death from TBI between 2000 and 2008 was 21.6 (95 percent confidence interval (CI) 21.3-21.9; see Notes). In 2008, the rate of TBI death was 20.6, slightly less than the average rate observed between 2000 and 2008 for North Carolina residents (Figure 3).

Although national TBI data are not available for 2008, the fatality rate for the most recent year available (2005) was 18.2⁸. Nationally, TBI deaths and hospitalizations appear to have declined over the past few decades, although this trend is not uniform for all causes of TBI^{9, 10}.

Figure 3: Rates of TBI Deaths: North Carolina Residents, 2000-2008



Data: NC Center for Health Statistics, 2008
Analysis: Injury Epidemiology and Surveillance Unit

Demographics of TBI Deaths:

In 2008, over 1,900 North Carolina residents died after sustaining a TBI. Table 1 provides demographic characteristics of these deaths. In North Carolina, certain populations are at a greater risk of suffering a fatal TBI:

- Men are considerably more likely to die from a TBI than women. Over two-thirds of all TBI deaths occur in the male population (71%). The rate of deaths from TBI in men is 30.0 (95% CI 28.4-31.6). The rate of deaths of TBI in women is 11.6 (95% CI 10.6-12.6).
- Hispanics (15.9, 95% CI 12.9-18.9) have lower rates of TBI death than non-Hispanics (21.0, 95% CI 20.0-22.0).
- American Indians have the highest rate of death due to TBI of all racial groups. American Indians have a rate of 34.1 (95% CI 23.7-44.5). This is nearly 1.6 times higher than the rate of death in whites (21.8, 95% CI 20.7-22.9).
- Adults older than 84 have the highest rate of death due to TBI of all age groups (116.8, 95% CI 99.4-134.2). Adults in this age group have a rate that is 33.4 times higher than children ages 10-14.

Definitions:

The CDC defines a TBI as a “blow or jolt to the head or a penetrating head injury that disrupts the function of the brain¹¹.”

- Not all blows to the head result in a TBI.
- Severity of TBIs may range from mild to severe. One measure of TBI severity is the Glasgow Coma Scale (GCS). The GCS is based on best eye, verbal, and motor response¹².
- In general, mild TBIs (often concussions) are associated with a complete recovery, although short-term memory loss and other neurologic disorders may be present¹². Loss of consciousness does *not* necessarily accompany a mild TBI. Adult populations, particularly the elderly, may have slower and less complete recovery than their younger counterparts¹³.
- Moderate TBIs are associated with transient loss of consciousness. An individual with a moderate TBI will suffer more serious symptoms than a mild TBI, such as persistent headache, repeated vomiting or nausea, seizures, memory loss, confusion, and etc³.
- Sufferers of severe TBIs demonstrate a complex combination of physical, cognitive, and behavioral challenges. Severe TBIs may result in a coma and carry a substantial risk for long-term disability or death¹².

All TBI deaths and injuries are classified using the World Health Organization’s International Classification of Disease codes ICD-10 (deaths) and ICD-9-CM (nonfatal injuries). Supplemental information is provided in the Notes (page 22) and Glossary sections (page 24).

**Table 1: Gender, Race, Hispanic-Ethnicity, and Age of
TBI Deaths: North Carolina Residents, 2008**

		Number	Percent	Rate [†]	95% Confidence Interval	
					Lower	Upper
Gender						
	Male	1,356	71.3%	30.0	28.4	31.6
	Female	547	28.7%	11.6	10.6	12.6
Hispanic Ethnicity						
	Hispanic	109	5.7%	15.9	12.9	18.9
	Non-Hispanic	1,791	94.3%	21.0	20.0	22.0
Race[§]						
	Asian	15	0.8%	*	*	*
	American Indian	41	2.2%	34.1	23.7	44.5
	Black	343	18.0%	16.9	15.1	18.7
	Other	2	0.1%	*	*	*
	White	1,501	78.9%	21.8	20.7	22.9
Age Group[¥]						
	00-04	39	2.1%	6.0	4.1	7.9
	05-09	9	0.5%	*	*	*
	10-14	21	1.1%	3.5	2.0	5.0
	15-19	117	6.2%	18.6	15.2	22.0
	20-24	160	8.4%	25.5	21.5	29.5
	25-34	261	13.7%	21.1	18.5	23.7
	35-44	257	13.5%	19.2	16.9	21.5
	45-54	273	14.4%	20.6	18.2	23.0
	55-64	218	11.5%	20.7	18.0	23.4
	65-74	151	7.9%	24.4	20.5	28.3
	75-84	221	11.6%	59.3	51.5	67.1
	85+	173	9.1%	116.8	99.4	134.2
Total		1,903	100.0%	20.6	19.7	21.5

*Rate is based on fewer than 20 deaths and is considered statistically unreliable.

†All rates are per 100,000 North Carolina residents.

§Missing 1 of unknown race.

¥Missing 3 of unknown age.

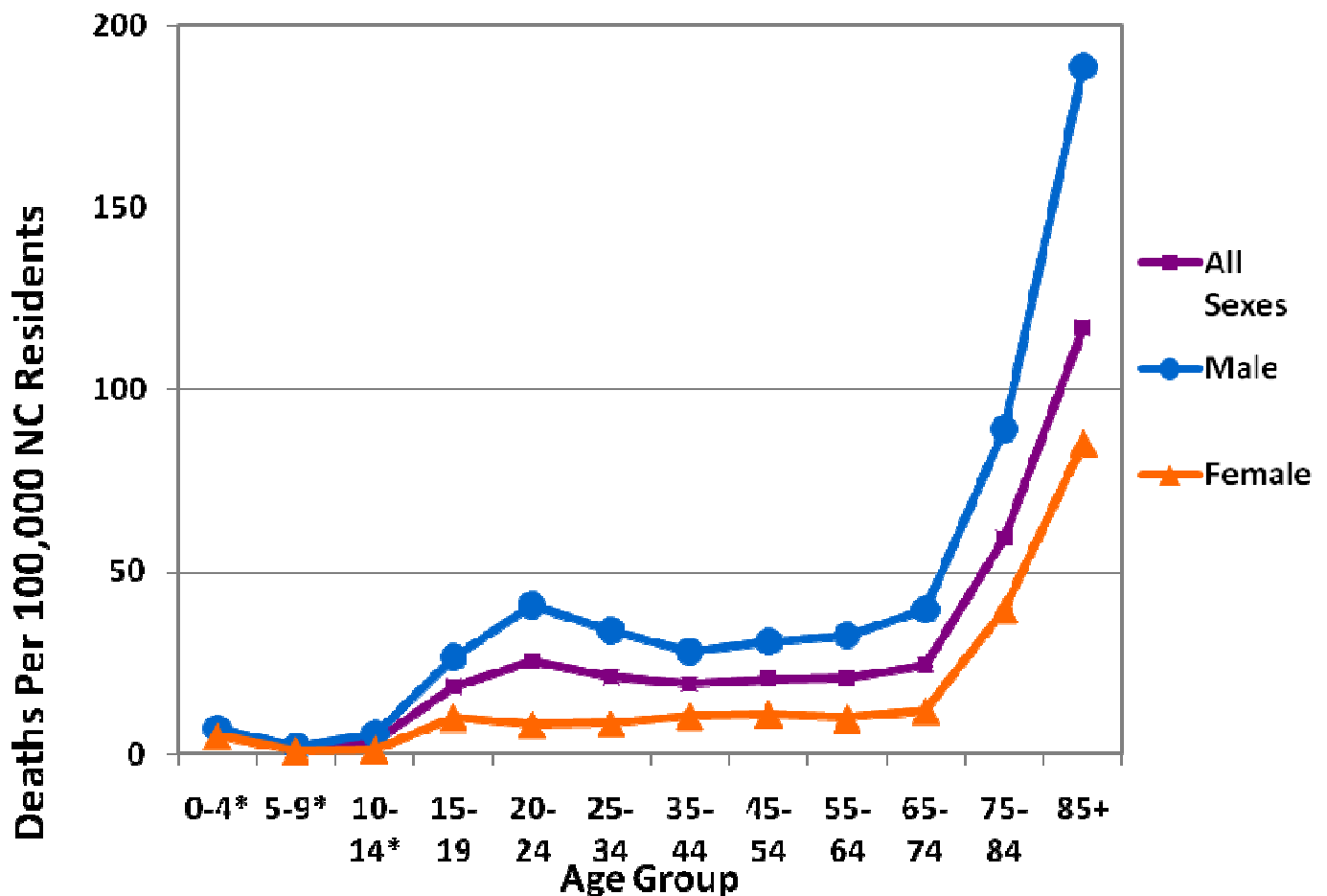
Data: NC Center for Health Statistics, 2008
Analysis: Injury Epidemiology and Surveillance Unit

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TBI rates differ considerably between different age groups and sexes. These trends are not unique to North Carolina. Nationally, males have higher rates of death from TBIs in comparison to females for all age groups. Additionally, young adult males and the elderly of both sexes are at an increased risk of a TBI fatality⁴. Figure 4 presents TBI deaths in North Carolina by age and gender:

- Males exhibit a small peak in deaths between the ages of 20 and 24 and a larger peak over the age of 84. These rates parallel trends observed nationally⁴.
- The female population does not exhibit a large uptick in the rate of death until the age of 75, although this peak is noticeably less than the peak observed in males.
- Rates of TBIs are the same or lower for females than males for all age groups.

Figure 4: Rates of TBI Deaths by Gender and Age: North Carolina Residents, 2008



Missing 3 of unknown age.

*Rate is based on fewer than 20 deaths and is considered statistically unreliable.

Data: NC Center for Health Statistics, 2008

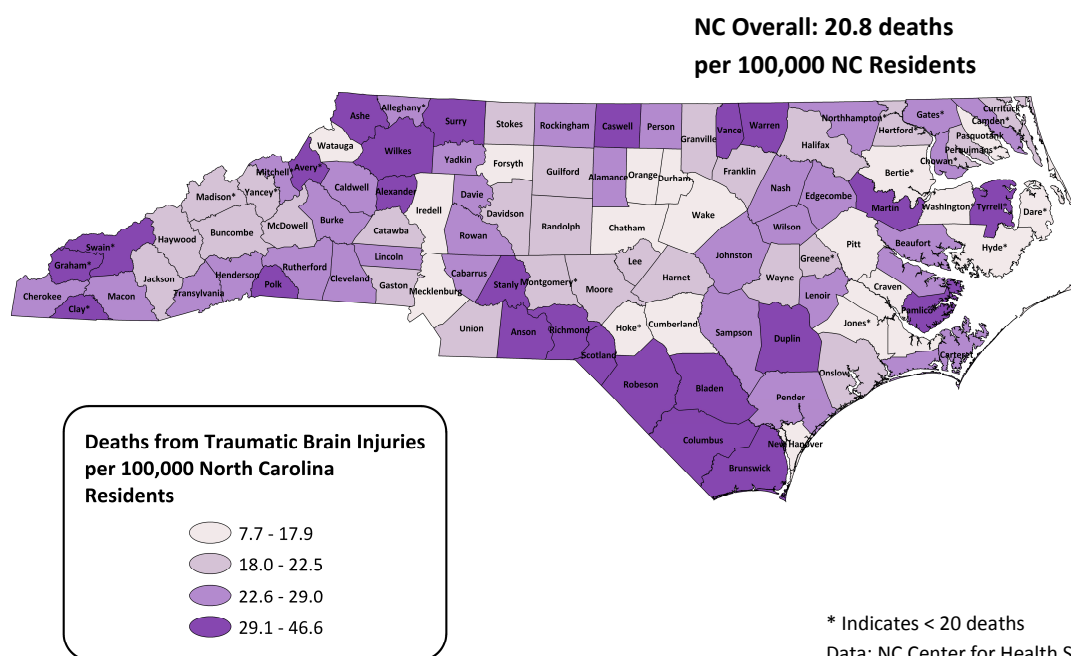
Analysis: Injury Epidemiology and Surveillance Unit

TBI Deaths by County from 2006 to 2008 (Pooled Population):

The rates of fatal TBIs are not distributed equally across the state of North Carolina. Figure 5 presents the rates of TBI death by county for the years 2006 through 2008. The rates should be interpreted with caution, however; counties with fewer than 20 deaths may have statistically unreliable rates. Additionally, differences in rates between counties are due to an array of factors including population, infrastructure, and geographic differences.

- During the years 2006-2008, North Carolina had 5,633 deaths and an average TBI mortality rate of 20.8 (95% CI 20.3-21.3).
- Of the 75 counties with greater than 20 deaths, Robeson County had the highest mortality rate due to TBI (39.3, 95% CI 33.0-45.6). Columbus County (38.2, 95% CI 28.7-47.7) and Anson County (37.0, 95% CI 23.3-50.7) had the second and third highest mortality rates, respectively.
- Of the counties with greater than 20 deaths, Wake (12.9, 95% CI 11.5-14.3), Orange (12.9, 95% CI 9.3-16.5), and Durham Counties (14.5, 95% CI 11.8-17.2) had the lowest rates of TBI mortality.

Figure 5: Rates of TBI Deaths by County: North Carolina Residents, 2006-2008



Demographics of TBI Hospitalizations and Emergency Department (ED) Visits:

Deaths make up only a small portion of TBIs; nonfatal injuries are far more common. Hospital discharge records and data from emergency departments (EDs) provide additional insight into the extent of TBIs in North Carolina.

Unfortunately, this study provides only a rough approximation of the full extent of nonfatal injuries in the state; injuries that are treated in outpatient clinics and in the home will not be captured by this study. Table 2 presents hospital discharge and ED data:

- North Carolina residents are three times more likely to be hospitalized and nearly 30 times more likely to visit the ED than to die from a TBI^{1, 5, 6, 7}.
- Although children between the ages of zero and four do not constitute a large percentage of deaths, they have high rates of hospitalization (47.4) and even higher rates of ED visits (919.9).
- Adults over the age of 84 have the highest rates of TBI deaths, hospitalizations, and ED visits.

For 2007, the median hospital bill for all hospital discharges due to TBI was about \$20,000 (\$150 - \$2, 519, 191) and the total hospital charges for North Carolina were over \$300 million.

Table 2: Gender and Age of Deaths, Hospital Discharges, and Emergency Department (ED) Visits due to TBI: North Carolina Residents, 2007 and 2008

	Death [§]		Hospital Discharge [¥]		ED Visits [§]	
	Number	Rate [†]	Number	Rate [†]	Number	Rate [†]
Gender[£]						
Male	1,356	30.0	4,520	102.3	28,319	626.9
Female	547	11.6	2,921	63.2	22,931	487.3
Age Group[¤]						
00-04	39	6.0	301	47.4	6,005	919.9
05-09	9	*	139	22.8	2,931	470.1
10-14	21	3.5	175	29.6	3,074	516.9
15-19	117	18.6	515	83.0	5,501	874.6
20-24	160	25.5	608	99.6	4,501	717.8
25-34	261	21.1	740	60.9	6,300	510.3
35-44	257	19.2	789	59.0	5,308	395.8
45-54	273	20.6	835	64.3	4,681	353.2
55-64	218	20.7	718	70.3	3,238	306.9
65-74	151	24.4	750	126.8	2,768	447.8
75-84	221	59.3	1,057	286.0	3,811	1,022.3
85+	173	116.8	814	572.4	3,112	2,101.9
Total	1,903	20.6	7,441	82.3	51,259	555.5

*Rate is based on fewer than 20 deaths and is considered statistically unreliable.

†All rates are per 100,000 North Carolina residents.

§Data are from 2008; ¥Data are from 2007

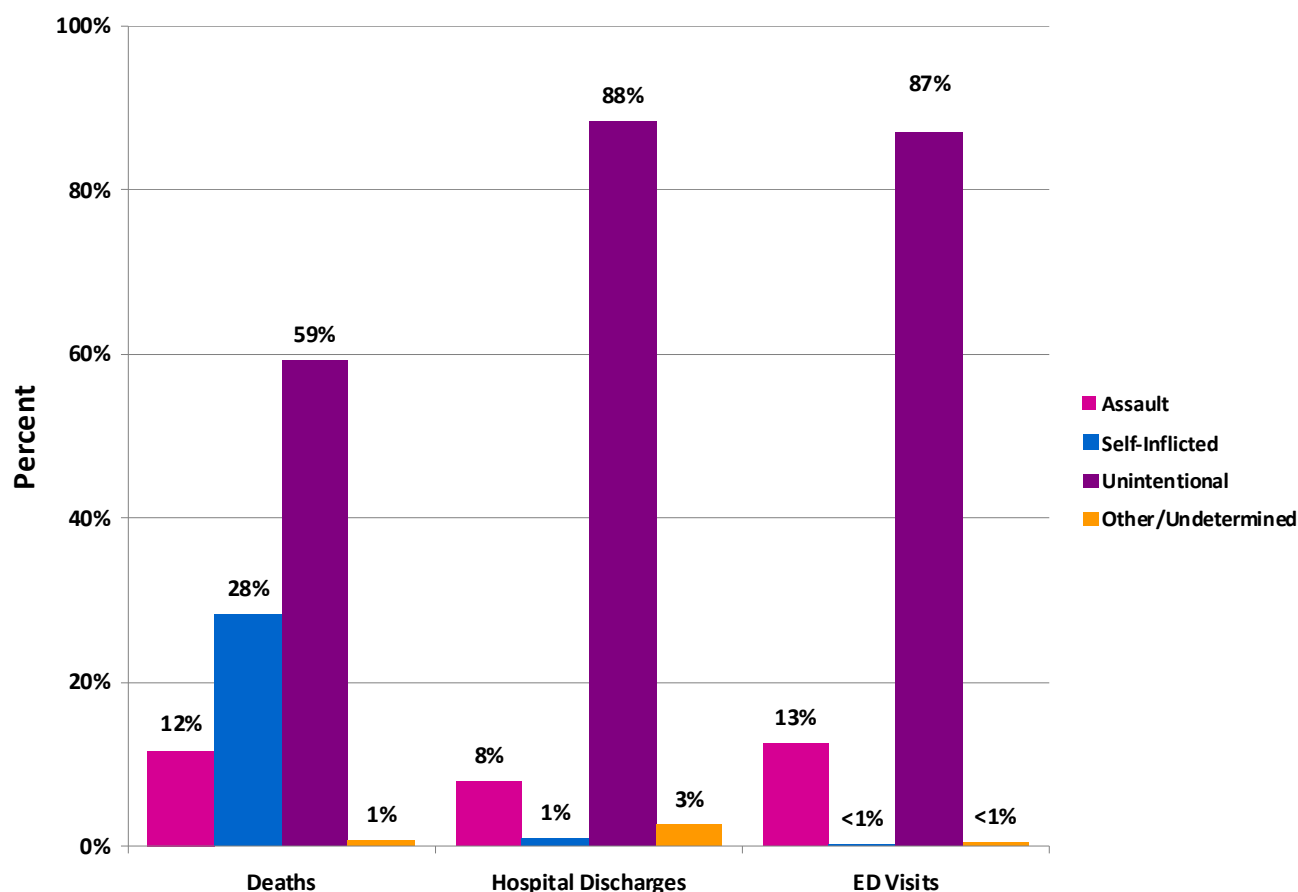
£ED: 9 missing gender ; ¤Deaths: 3 missing age; ED: 29 missing age.

Data: NC Center for Health Statistics, 2007, 2008; NC DETECT, 2008
Analysis: Injury Epidemiology and Surveillance Unit

Manner of Injury:

TBI injuries can be either intentional (self-inflicted or assault), unintentional, or undetermined. As with most types of injury, unintentional injuries are the most common manner of injury. Unintentional injuries account for 59 percent of deaths, 88 percent of hospitalizations, and 87 percent of ED visits. However, the manner of injury is distributed more equitably in deaths than in hospitalizations and ED visits (Figure 6).

Figure 6: Reported Manner of Injury of TBI Deaths*, Hospital Discharges[†], and ED Visits*: North Carolina Residents, 2007 and 2008



*Data are from 2008.

†Data are from 2007.

Data: NC Center for Health Statistics, 2007, 2008; NC DETECT, 2008

Analysis: Injury Epidemiology and Surveillance Unit

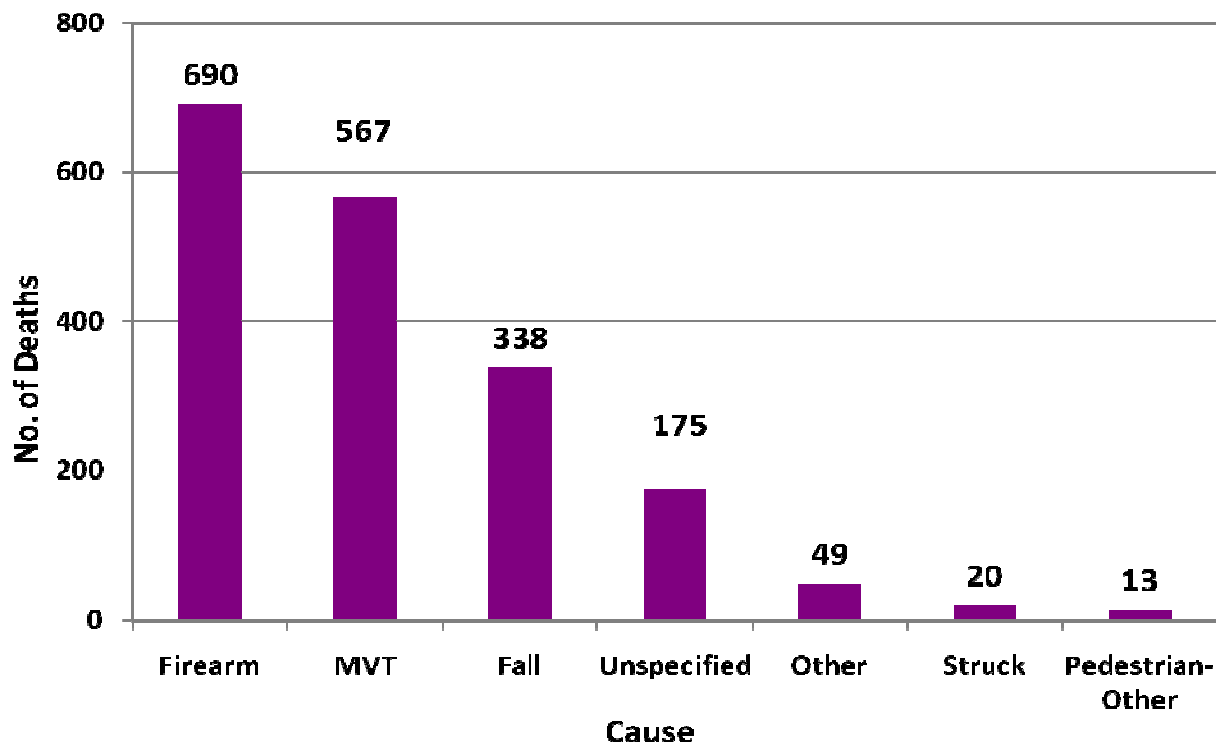
Mechanism(s) of Injury:

Deaths:

TBIs may be due to any of a wide assortment of causes. Causes of death are classified using the International Classification of Disease, Version 10 (ICD-10) using codes established by the CDC State Injury Indicators Report¹⁴. Figures 7 through 11 present leading mechanisms of death. For additional information regarding these figures, including specific coding used to generate these figures, please see the Notes and Glossary sections.

- The leading mechanism of TBI deaths in North Carolina is firearms with 690 deaths. Firearm-related deaths account for over 36 percent of all TBI deaths. Most of these deaths are either due to assault or self-inflicted injuries (Figure 7). Firearms are also the leading cause of TBI deaths nationally. Nine out of 10 TBIs due to firearms will end in death¹⁵.
- Motor vehicle-traffic crashes (MVT) are the second leading mechanism of death with 567 deaths (30%, Figure 7).
- The third leading mechanism of TBI deaths was falls with 338 deaths in 2008 (18%, Figure 7).

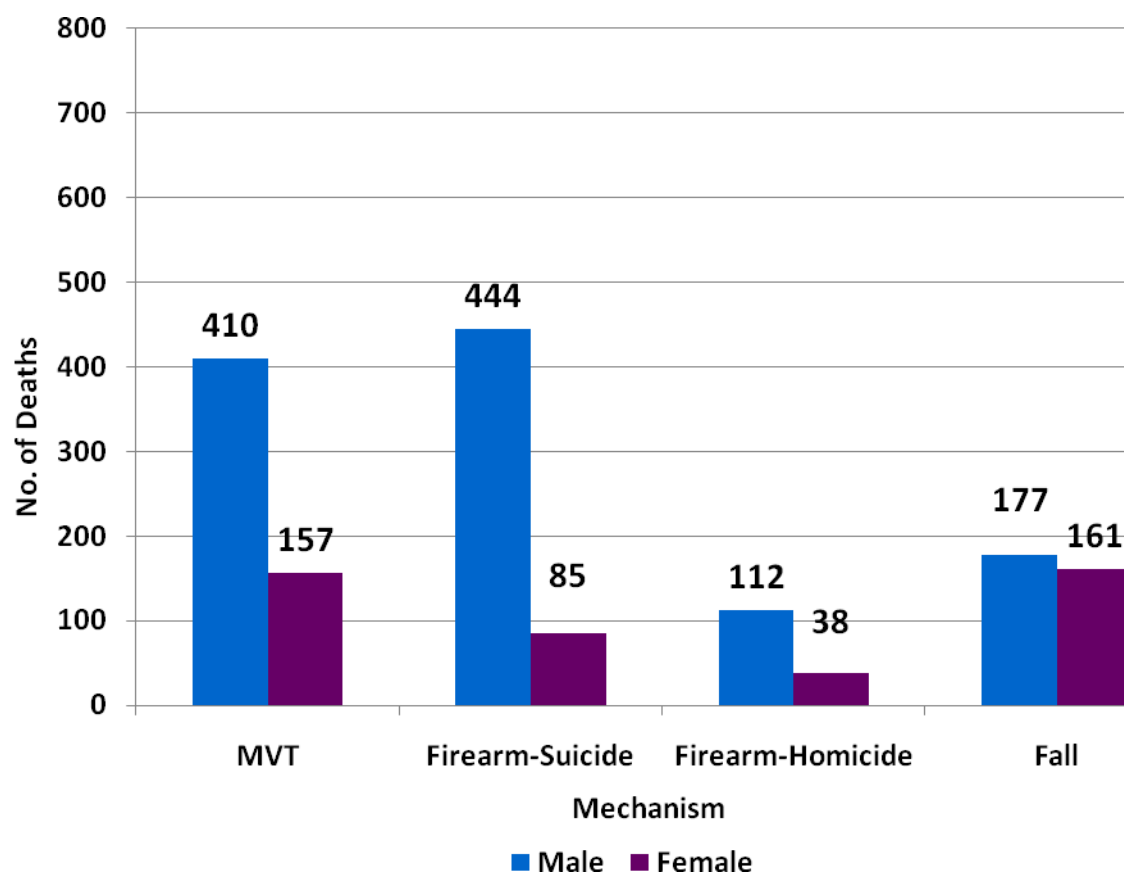
Figure 7: Leading Mechanism of TBI Deaths: North Carolina Residents, 2008



Data: NC Center for Health Statistics, 2008
Analysis: Injury Epidemiology and Surveillance Unit

- For all mechanisms of death, there are more male than female deaths due to TBI (Figure 8).
- The three leading mechanisms of TBI deaths in males are: 1) firearm-suicide, 2) MVT crashes, and 3) falls (Figure 8).
- The three leading mechanisms of TBI deaths in females are: 1) falls, 2) MVT crashes, and 3) firearm-suicide (Figure 8).
- Males are five times more likely to die from a TBI associated with firearm-suicide and three times more likely to die from a TBI associated with firearm-homicide than females.

Figure 8: Leading Mechanisms of TBI Deaths by Gender: North Carolina Residents, 2008

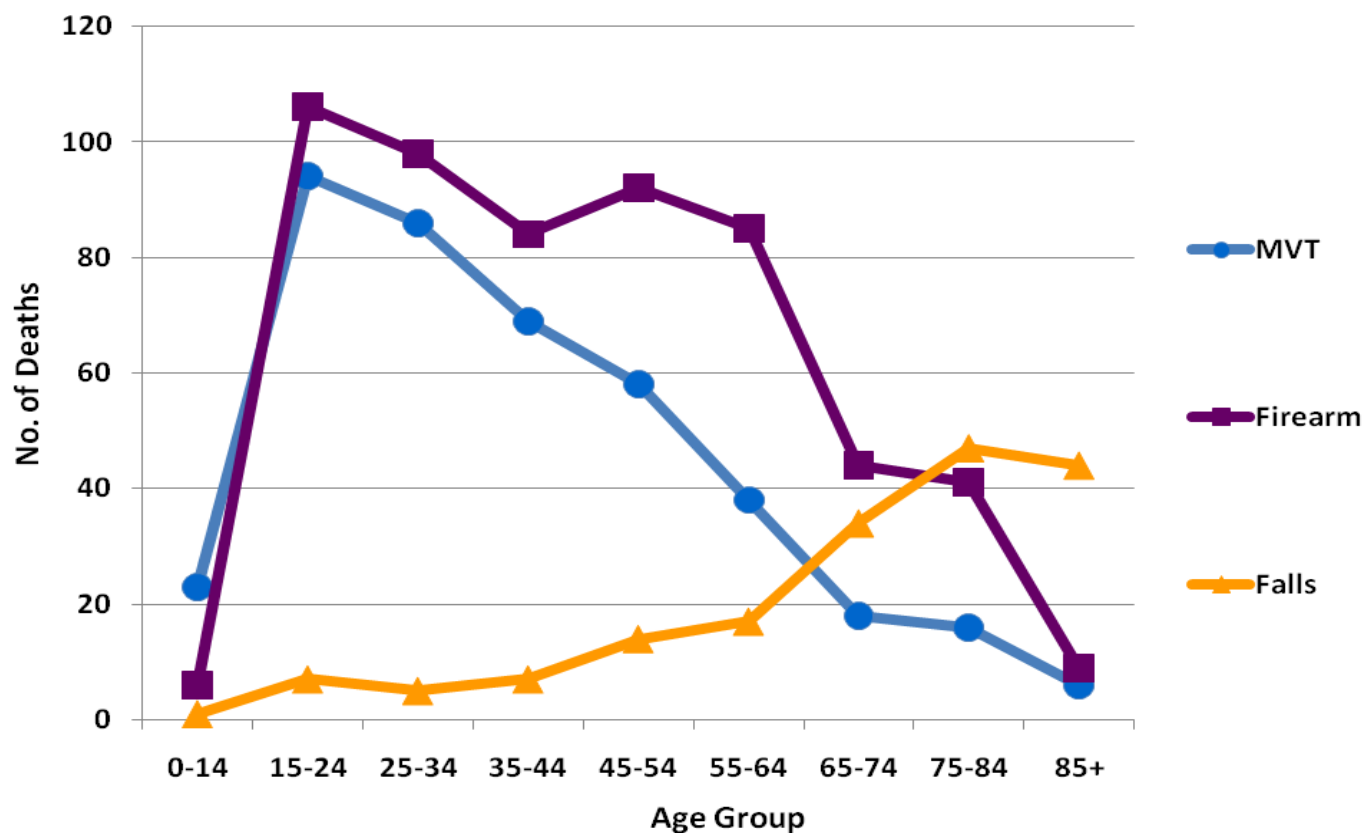


Data: NC Center for Health Statistics, 2008
 Analysis: Injury Epidemiology and Surveillance Unit

At various stages in life, different mechanisms of injury are more prevalent in certain age groups than others. In 2008, causes of TBI differed considerably by both age *and* gender. Figures 9 and 10 display these trends.

- Male TBI deaths were relatively low in number until the age of fifteen.
- MVT (86 deaths) and firearm deaths (98 deaths) peaked in males between the ages of 25 and 34. Deaths from MVT crashes dropped off more sharply than firearm-related deaths (Figure 9).
- The number of male deaths due to falls rose in middle-age when deaths due to MVT crashes and firearms dropped sharply (Figure 9).

Figure 9: Top Three Mechanisms of TBI Death in Males: North Carolina Residents, 2008



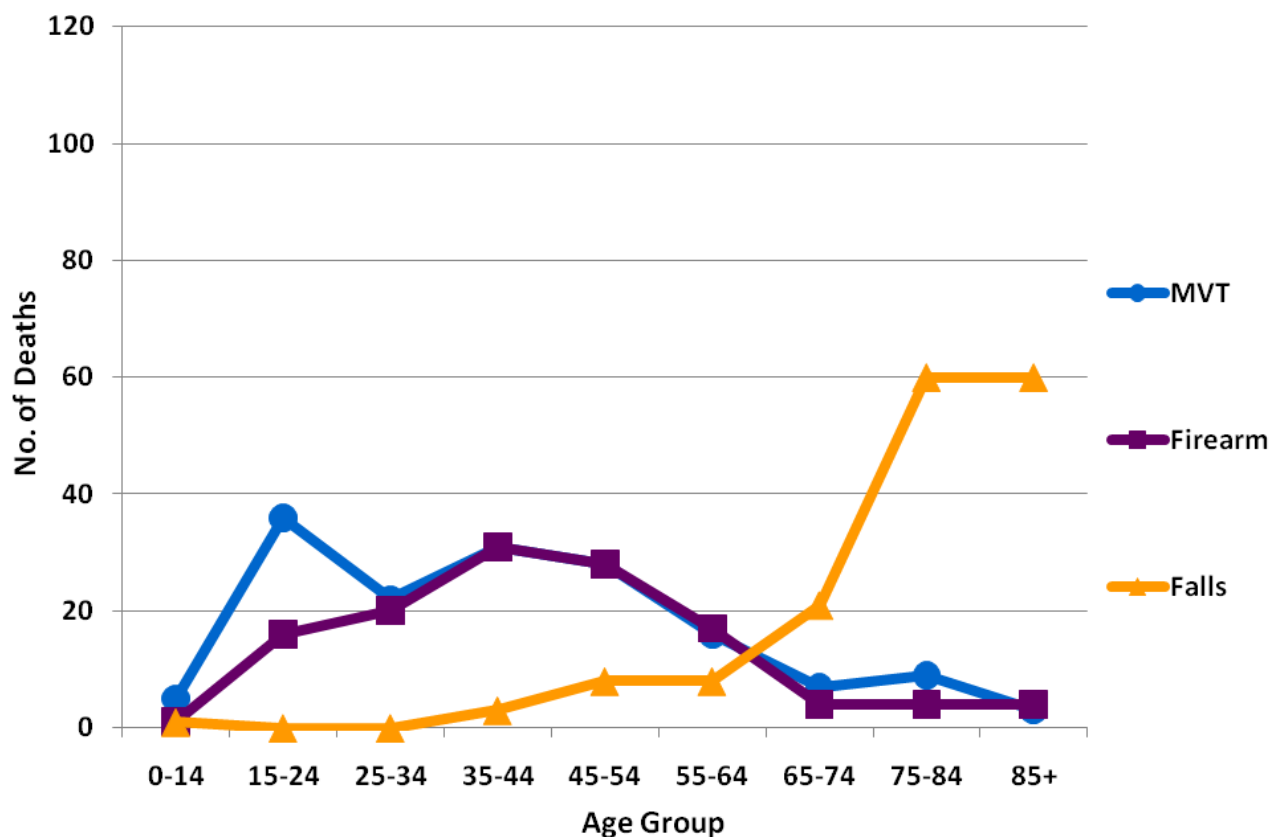
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Data: NC Center for Health Statistics, 2008

Analysis: Injury Epidemiology and Surveillance Unit

- In 2008, female deaths displayed different trends than male deaths. In contrast to males, females displayed a small peak in MVT-related deaths between the ages of 15 and 19 (26 deaths; Figure 10).
- Unlike males, females did not exhibit a peak in TBI deaths between the ages of 25 and 34 (Figure 10).
- MVT (31 deaths) and firearm deaths (31 deaths) peaked in females between 35 and 44 (Figure 10).
- Similar to males, female TBI deaths due to falls rose sharply in individuals older than 55 years of age (Figure 10).

Figure 10: Top Three Mechanisms of TBI Death in Females: North Carolina Residents, 2008

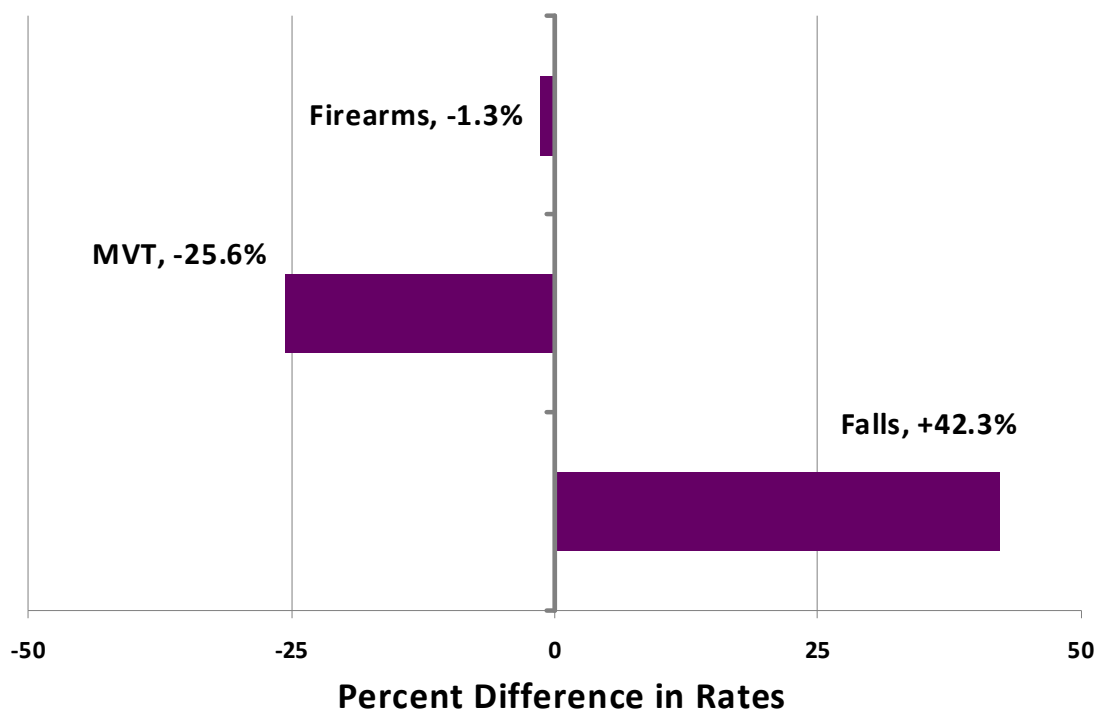


Data: NC Center for Health Statistics, 2008
 Analysis: Injury Epidemiology and Surveillance Unit

Since 2000, trends regarding the causes of TBI deaths have changed (Figure 11).

- In 2000, the leading cause of TBI death was MVT crashes with 662 deaths and a rate of 8.2 (95% CI 7.6-8.8). In 2008, the number of MVT deaths had dropped to 567 deaths and a rate of 6.1 (95% CI 5.6-6.6). Between 2000 and 2008 the rate of MVT deaths due to TBI decreased by over 25 percent.
- In 2008, the leading cause of TBI death was firearms with a rate of 7.5 (95% CI 6.9-8.1). The rate of firearm-related deaths has not changed considerably since 2000.
- The rate of TBI-related falls in North Carolina residents has increased by over 42 percent since 2000. In 2000, the rate of TBI deaths due to falls was 2.6 (95% CI 2.2-3.0). In 2008, this rate had increased to 3.7 (95% CI 3.3-4.1). This trend mirrors the increase in all fall-related deaths in North Carolina over the last decade¹⁶.

Figure 11: Percent Difference in Rates of Leading Mechanisms of TBI Death: North Carolina Residents, 2000 versus 2008



Data: NC Center for Health Statistics, 2008
Analysis: Injury Epidemiology and Surveillance Unit

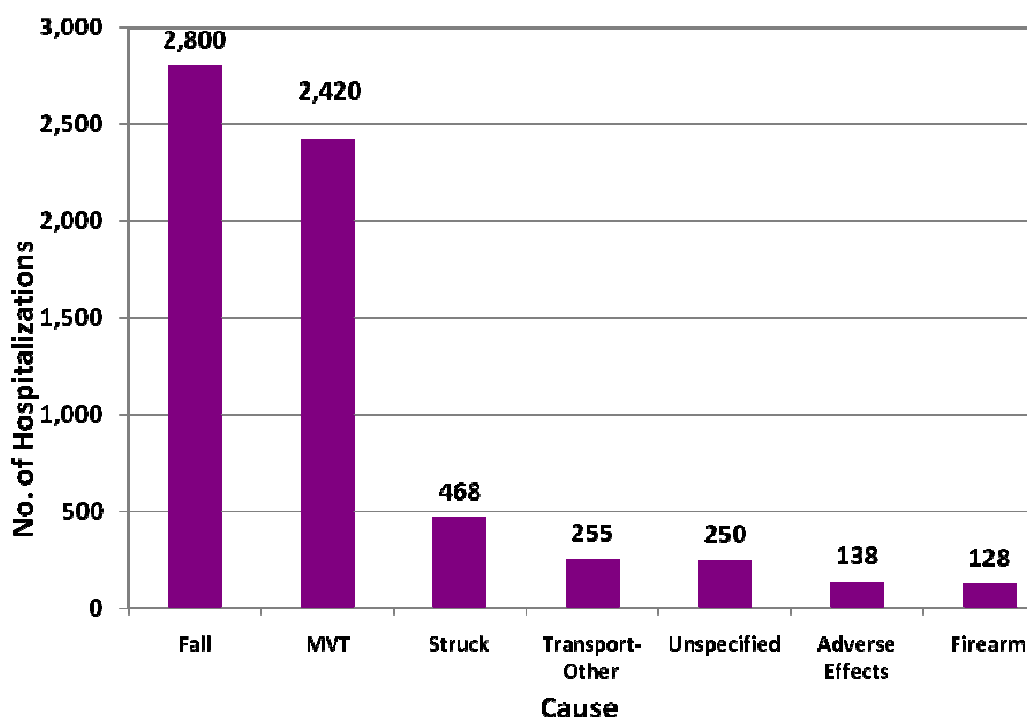
Mechanism(s) of Injury:

Hospitalizations:

Hospitalizations due to TBIs are more common than deaths. Unfortunately, many persons with TBIs will require long-term medical care following a TBI¹⁷. Nationally, an estimated 70,000-90,000 individuals will require long-term care post-TBI¹⁸. As the average life-expectancy of an individual who survives a severe TBI is 50 years post-injury, the burden on the health care system may be quite extensive¹⁹. Figure 12 presents leading causes of TBI hospitalizations for 2007⁵:

- Unlike deaths, the leading mechanism of hospitalization in North Carolina is falls (2,800 hospitalizations).
- MVT crashes are the second leading mechanism of hospitalizations (2,420 hospitalizations).
- After MVT crashes, there is a large drop between the second and third leading mechanisms of TBI hospitalizations. TBI hospitalizations due to being struck by an object accounted for only 468 hospitalizations; about one-fifth of the number of MVT crashes.

Figure 12: Leading Causes of TBI Injuries--Hospitalizations: North Carolina Residents, 2007



Data: NC Center for Health Statistics, 2007

Analysis: Injury Epidemiology and Surveillance Unit

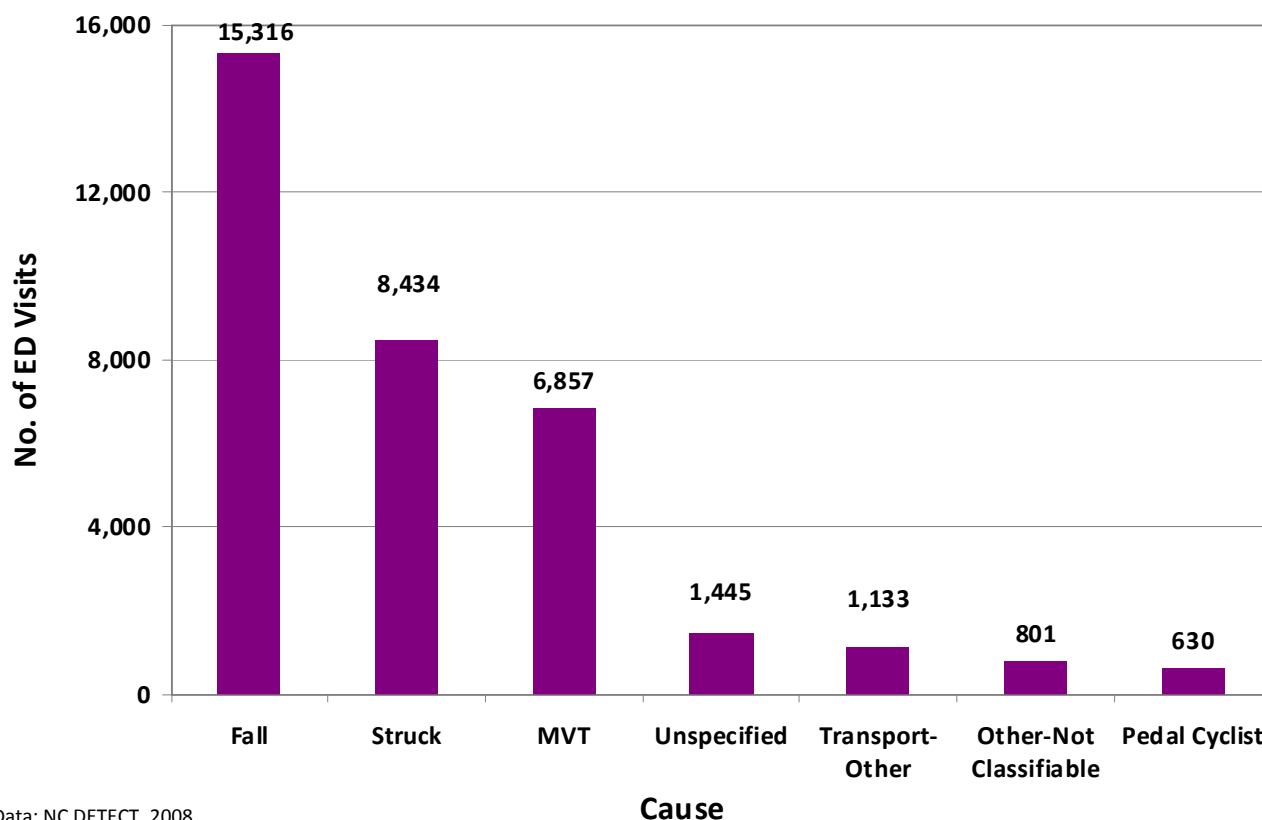
Mechanism(s) of Injury:

Emergency Department (ED) Visits:

There are more ED visits due to TBIs than all hospitalizations and deaths combined. ED data capture some of the less severe TBIs. Even mild and moderate TBIs may result in disability, especially in children and the elderly¹³. For example, TBIs in early adulthood may increase the risk of developing Alzheimer's disease and Parkinson's disease later in life³. Also, individuals with a history of a TBI may be at an increased risk of suffering from a future TBI²⁰. Unfortunately, TBIs may be underreported in the ED; especially in patients presenting acute life-threatening injuries²¹. Figure 13 presents leading causes of ED visits⁶:

- Similar to hospitalizations, falls were the leading mechanism of ED visits (15,316 visits).
- In 2008, nearly twice as many North Carolina residents visited the ED due to TBIs relating to falls than TBIs relating to being struck.
- In 2008, being struck was the second leading mechanism of TBI (8,434 visits) and MVT was the third leading mechanism of TBI (6,857 visits).

Figure 13: Leading Causes of TBI Injuries - ED Visits: North Carolina Residents, 2008



Data: NC DETECT, 2008

Analysis: Injury Epidemiology and Surveillance Unit

Conclusions:

Traumatic brain injury (TBI) is a significant source of morbidity and mortality for North Carolina residents and exacts a heavy toll on the life, health, and economic security of the individual, family unit, community, and state. TBI is a complex problem in that it affects all age groups, from the very young to the very old, all races, and encompasses a large number of causes, many of which are unrelated. In order to fully address this complicated public health issue, disparate organizations with backgrounds in health, advocacy, research, education, law enforcement, and policy must partner in order to relieve the burden that TBIs place on North Carolina. Additionally, continuing population-based surveillance is necessary to provide data on changing trends regarding TBI. Hopefully the data provided in this document and upcoming publications will be used to aid in TBI prevention and to spur future research priorities.

Additional Sources of Information:**North Carolina:****North Carolina Division of Public Health, Injury and Violence Prevention Branch**

Phone: (919) 707-5425

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North Carolina Division of Mental Health, Developmental Disabilities, and Substance Abuse

Traumatic Brain Injury Program

Phone: (919) 715-5989

Email: TBIContact@dhhs.nc.gov

Website: www.dhhs.state.nc.us/mhddsas/tbi/index.htm

Brain Injury Association of North Carolina

Phone: (800) 377-1464

Email: bianc@bianc.net

Website: www.bianc.net

National:**Centers for Disease Control and Prevention, National Center for Injury Prevention and Control**

Phone: (800) 232-4636

Email: cdcinfo@cdc.gov

Website: www.cdc.gov/ncipc/tbi/TBI.htm

National Institute of Neurological Disorders and Stroke

Phone: (800) 352-9424

Website: www.ninds.nih.gov/disorders/tbi/tbi.htm

Brain Injury Association of America

Phone: (800) 444-6443

Email: braininjuryinfo@biausa.org

Website: www.biausa.org

Brain Trauma Foundation

Phone: (212) 772-0608

Website: www.braintrauma.org

Notes:

Rates: All rates (unless documented otherwise) are per 100,000 North Carolina residents. Rates are not age-adjusted, unless labeled as such.

95 Percent Confidence Intervals: Data are frequently reported as point estimates with an associated 95 percent confidence interval. A confidence interval is the range of values within which the expected “true” value falls 95 percent of the time. In general, a rate with a large numerator will have a narrower 95 percent confidence interval than a rate with a small numerator²².

Population Estimates: The North Carolina State Center for Health Statistics provided population data for the years 1990-2008. These estimates originate from the National Center of Health Statistics’ Bridged Population Files.

Death Data: The North Carolina State Center for Health Statistics provided death certificate data for every death in North Carolina. Only North Carolina residents with a North Carolina county address were considered in our analyses. Deaths were limited to events in which the primary cause of death was identified as an injury. Primary cause of death was assigned with the International Classification, 10th Revision (ICD-10) codes. The coding used to classify traumatic brain injury fatalities was: S01.0-S01.9, S02.0, S02.1, S02.3, S02.7-S02.9, S04.0, S06.0-S06.9, S07.0, S07.1, S07.8, S07.9, S09.7-S09.9, T01.0, T02.0, T04.0, T06.0, T90.1, T90.2, T90.4, T90.5, T90.8, and T90.9.

Hospital Discharge Data: The North Carolina Center for Health Statistics provided hospital discharge data for every hospital discharge of North Carolina residents. A hospital discharge occurs after a patient leaves a hospital following admission. This data does not represent number of patients, but number of discharges (multiple discharges per patient are possible). Cause of injury was assigned with International Classification, 9th Revision, Clinical Modification (ICD-9-CM) External Causes of Injury codes (E Codes). The coding used to classify traumatic brain injuries was: 800.0-801.9, 803.0-804.9, 850.0-854.19, 950.1-950.3, 959.01, and 995.55.

Emergency Department Data: The North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) is a state system that collects and monitors emergency department (ED) for public health purposes. NC DETECT receives data on at least a daily basis from hospital emergency departments statewide to provide early detection and timely public health surveillance. As of 01/2007, NC DETECT was receiving data from 90 of the 112 hospital EDs. The ED data and the hospital discharge data are not mutually exclusive. Cause of injury was assigned with International Classification, 9th Revision, Clinical Modification (ICD-9-CM) External Causes of Injury codes (E Codes). The coding used to classify traumatic brain injuries was: 800.0-801.9, 803.0-804.9, 850.0-854.19, 950.1-950.3, 959.01, and 995.55.

Glossary²³:

Adult: Person 18 years of age or older at date of death/injury.

Adverse effects: An injury caused by complications following the administration of a medication or medical procedure.

Assault: Injury resulting from an act of violence where physical force by one or more persons is used with the intent of causing harm, injury, or death to another person.

Child: Person less than 18 years of age at date of death/injury.

Fall: An injury caused by descending rapidly and striking a surface.

Firearm: An injury caused by a projectile shot by a powder-charged gun. Firearm-related injuries include hand-guns, shot-guns, and rifles. Firearm-related injuries do not include paint, nail, or air guns.

Intent of injury: Whether or not an act that caused an injury was committed on purpose.

Intentional injury: An injury caused by a purposeful act by oneself (self-inflicted) or another individual (assault).

Mechanism (cause) of death: The reason or event that precipitates the death/injury.

Motor vehicle-traffic (MVT): A crash involving a motor vehicle on a highway, street, or road.

North Carolina resident: A resident of North Carolina with a verifiable county of residence. All deaths and injuries reported in this report are North Carolina residents.

Other-not classifiable: An injury by a known cause that does not fit into an established category.

Pedal cyclist: An injury to a pedal cyclist caused by a collision with a human, animal, or inanimate object such as a vehicle.

Pedestrian: An injury to a person caused by a collision with a vehicle including a motor vehicle, bicycle, train, and etc.

Rate: Calculated as count x 100,000/population.

Self-inflicted injury: An injury caused by an act to deliberately harm oneself.

Struck: An injury caused by being hit or crushed by a human, animal, or inanimate object other than a vehicle or machinery.

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Transport-other: An injury caused by a person boarding or riding a vehicle other than a motor vehicle or bicycle such as animal-drawn vehicles, ATVs, ski-lifts, and etc.

Traumatic brain injury (TBI): An injury caused by a blow to the head or a penetrating head injury that disrupts the function of the brain.

Undetermined Intent: An injury in which the medical examiner/hospital/emergency department did not have enough information to describe the intent of injury.

Unintentional injury: An injury that is not caused by an act with intent to harm oneself or another individual.

Unspecified injury: An injury in which the medical examiner/hospital/emergency department did not have enough information to describe the cause of injury.

References:

1. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. *North Carolina Mortality Data Files: 2000-2008* [Computer File]. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]. Retrieved 5 February 2010.
2. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. Table A: Leading causes of death by age group North Carolina residents, 2008. *Vital Statistics—Vol. II*. 2010. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]; 2009. Retrieved 22 February 2010 from www.schs.state.nc.us/SCHS/deaths/lcd/2008/pdf/TblsA-F.pdf.
3. United States Department of Health and Human Services, National Institutes of Health, National Institute of Neurological Disorders and Stroke, Office of Communication and Public Liaison. *Traumatic brain injury: Hope through research*. U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Neurological Disorders and Stroke, Office of Communication and Public Liaison; 2002. Retrieved 15 February 2010 from www.ninds.nih.gov/disorders/tbi/pubs_tbi.html.
4. Langlois, J.A., Rutland-Brown, W., & Thomas, K.E. *Traumatic Brain Injury in the United States. Emergency Department Visits, Hospitalizations, and Deaths*. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Injury Response; 2006. Retrieved 22 February 2010 from www.cdc.gov/ncipc/pub-res/tbi_in_us_04/tbi%20in%20th%20us_jan_2006.pdf.
5. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. *North Carolina Hospital Discharge Data: 2007* [Computer File]. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]; 2009. Retrieved 5 February 2010.
6. The North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT). *North Carolina Emergency Department Data: 2008* [Computer File]. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health; 2008. Retrieved 5 February 2010.
7. United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System. *Vintage 2008 Bridged-Race Postcensal Population Estimates* [Computer File]. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System; 2008. Retrieved 5 February 2010.

8. Johnson, R.L., Thomas, R.G., Thomas, K.E., & Sarmiento, K. State Injury Indicators Report, Fourth Edition—2005 Data. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2009.
9. Thurman, D.J., Alverson, C., Dunn, K.A., Guerrero, J., & Snizek, J.E. Traumatic brain injury in the United States: A public health perspective. *The Journal of Head Trauma Rehabilitation*. 1999; 14 (6): 602-615.
10. Bruns, J. Jr. & Hauser, W.A. The epidemiology of traumatic brain injury: A review. *Epilepsia*. 2003; 44(10): 2-10.
11. United States Department of Health and Human Services, Centers for Disease Control and Prevention. *Facts about Traumatic Brain Injury*. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2006. Retrieved 23 February 2010 from www.cdc.gov/NCIPC/tbi/FactSheets/Facts_About_TBI.pdf.
12. Ghajar, J. Traumatic brain injury. *The Lancet*; 2000:923-929.
13. Carroll, L.J., Cassidy, J.D., Peloso, P.M., Borg, J., van Holst, H., Holm, L., Paniak, C., & Pepin, M. Prognosis for mild traumatic brain injury: Results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabilitation Medicine*. 2004; 43: 84-105.
14. United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *State Injury Indicators Report. Fourth Edition—2005 Data*. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2009.
15. United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *Traumatic Brain Injury in the United States—A Report to Congress*. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 1999.
16. Woody, Jennifer. *The Burden of Unintentional Falls in North Carolina*. North Carolina Department of Health and Human Services, Division of Public Health, Injury and Violence Prevention Branch. Raleigh, N.C.; 2009.
17. Hoofien, D., Gilboa, A., Vakil, E., & Donovan, P.J. Traumatic brain injury (TBI) 10-20 years later: A comprehensive outcome study of psychiatric symptomatology, cognitive abilities, and psychosocial functioning. *Brain Injury*. 2001; 15 (3): 189-209.
18. The National Institutes of Health. Consensus development on rehabilitation of persons with traumatic brain injury. *Journal of the American Medical Association*. 1999; 282: 974-983.
19. Chamberlain, A.M. Head injury: The challenge. *Traumatic Brain Injury Rehabilitation: Services Treatments, and Outcomes*. London, U.K.: Chapman & Hall. 1995.

20. Zemper, E.D. Two-year prospective study of relative risk of a second cerebral concussion. *Archives of Physical Medicine and Rehabilitation*. 2003; 82 (9): 653-659.
21. Powell, J.M., Ferraro, J.V., Dikmen, S.S., Temkin, N.R., Bell, K.R. Accuracy of mild traumatic brain injury diagnosis. *Archives of Physical Medicine and Rehabilitation*. 2008; 89: 1550-1555.
22. Buescher, P.A. Problems with rates based on small numbers. *Statistical Primer*. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]; Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health; 2008. Retrieved 10 April 2010 from www.schs.state.nc.us/SCHS/pdf/primer12_2.pdf.
23. United States Department of Health and Human Services, Centers for Disease Control and Prevention, Injury Center. *Definitions for WISQARS*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Injury Center; 2007. Retrieved 9 April 2010 from www.cdc.gov/ncipc/wisqars/nonfatal/definitions.html.